Unplugged Versus Plugged Gamification – A Comparative Study in Higher Education on Engagement, Motivation and Teachers' Perception

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Abstract. This research delves into the realm of gamification in higher education, specifically contrasting unplugged versus plugged gamification techniques. Through a systematic literature review, we identified key effects of unplugged gamification, such as enhanced student computational thinking skills. A subsequent experimental study was conducted to compare the efficacy of unplugged (Blue&Go!) and plugged (Kahoot!) gamification platforms in fostering student engagement and motivation. Our findings suggest that while both platforms positively influenced engagement, participants dis-played a higher engagement level with Kahoot!, potentially due to their familiarity and comfort with the system. However, Blue&Go! excelled in promoting motivation, interest, and immersion. A notable discovery was the impact of teaching experience on participants' engagement levels, with those lacking teaching experience showing stronger levels of motivation and interest across both platforms. Resource constraints, including time, money, and workload, were found to influence gamified application usage intentions, especially among experienced educators. While our study under-scores the promising potential of unplugged gamification, certain limitations, including the small scale of the experiment and participant diversity, suggest that broader studies are required for more definitive conclusions.

Keywords: Gamification · plugged and unplugged · higher education · Kahoot · Blue&Go · Motivation · Engagement

1 Introduction

The integration of technology into educational frameworks has catalyzed a shift from traditional lectures to dynamic digital learning experiences. Amidst this transformation, enhancing student engagement is paramount. Gamification, described by [1], introduces game elements into non-game settings, promoting greater user engagement and motivation by forging emotional connections between users and the system. In higher education, gamification has proven beneficial in boosting student engagement, motivation, and performance [2]. Tools like Kahoot and Quizziz incorporate game mechanics like points

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and leaderboards [3]. However, implementing gamification demands careful planning [4].

The landscape bifurcates into 'plugged gamification', operating entirely digitally, and 'unplugged gamification', utilizing tangible, non-digital elements [5]. While unplugged learning has demonstrated potential science [6, 7], it hasn't been thoroughly explored under the gamification banner. While gamification has been developed in various ways and with different design frameworks [8], the concept of unplugged gamification is relatively new, and limited studies and research consensus around its development are available to determine its benefits and effects.

This study seeks to: (a) Unravel the effects of unplugged gamification in higher education, (b) Compare it with plugged gamification, and (c) Offer insights into the selection criteria for gamification techniques concerning resources and efficacy. We will address the following research questions:

- RQ1: What factors influence unplugged gamification's impact on higher education?
- RQ2: How does unplugged gamification compare to plugged gamification in terms of impact?
- RQ3: What drives the choice of gamification techniques considering resource constraints and effectiveness?

2 Background

Gamification, in educational contexts, integrates game mechanics such as points, badges, and levels to amplify engagement and motivation [9]. A parallel yet distinct approach is 'serious gaming', which employs games primarily as educational or training tools [9]. By weaving game elements into teaching, gamification becomes a potent strategy to stimulate active student participation.

The rising integration of technology in education has propelled gamification's popularity, promising a myriad of advantages [10]. A review by [2] attests to its positive impact on aspects like student engagement, motivation, and performance. Research has delved into gamification's myriad applications: from motivating students via badges and leaderboards [11] to fostering collaboration [12]. While the effectiveness of digital gamification in higher education has been acknowledged [13], there's a dearth of exploration into non-digital methodologies.

In the educational gamification arena, studies have juxtaposed 'unplugged' (non-digital) with 'plugged' (digital) methods, especially in primary education [14]. A systematic review even charted the territories of both gamification types, examining their applications and game elements [15]. However, a unified understanding of "gamification and unplugged" activities remains elusive, underscoring the need for more research [5].

Addressing this gap, our research delineates a methodology to assess the efficacy of both gamification types in higher education. By examining their impact across five engagement dimensions – motivation, interest, immersion, achievability, and purpose – we aim to enhance the understanding of unplugged gamification's role in higher education. This exploration will shed light on the effectiveness of both types in terms of engagement, motivation, learning outcomes, and the influence of resource constraints.

3 Methodology

The design of this study was divided into three stages: (1) Development of a systematic review on ways to measure the effectiveness of a gamification system, (2) data collection through questionnaires validated in sessions with groups of participants, and (3) Data analysis.

Initiating with an exhaustive literature review, the study delved into the nexus between gamification and education. Utilizing databases such as Google Scholar and IEEE Xplore, the research hinged on specific keywords, prioritizing peer-reviewed content from pertinent domains like computer science and psychology (see Table 1). As a result of the review, it was decided to focus the attention of the study on the analysis of three variables: (a) Engagement, (b) Motivation, and (c) Perceptions related to resource-effectiveness.

Data collection, conducted in the University of Twente, took a total of 4 weeks, and juxtapose two gamification strategies: the digital (plugged) approach using the web application Kahoot! and the tangible (unplugged) method via Blue&Go! a self-designed gamification system. The methodology involved 21 participants from the University with diverse demographics in terms of gender, age, nationality, and education level. Eight participants had teaching experience (including Lecturers, Professors, etc.), and 13 participants had no-experienced (BSc, MSc, and PhD candidates). Participants were grouped in sets of no more than 8 individuals. Each group was invited to attend a concise 30-min lecture on the topic of "Introduction to Gamification." During the first half of the lecture, participants engaged by responding to questions through the Kahoot application on their mobile devices.

In the second half, participants collaborated in pairs, utilizing the Blue&Go! tangible devices. These devices incorporate buttons featuring lights and sounds, functioning much like those used in television game shows, registering which team was the quickest to respond. The instructor initiated each question either verbally or by referencing the content on the slides, subsequently activating the buttons to allow students to request participation. Upon pressing a button and providing their response, the instructor used a controller to indicate whether the answer was correct or incorrect. In case of an incorrect response, the buttons were reactivated to offer other students a chance to answer. Conversely, if the response was correct, the question concluded, and the student earned points in the form of merits. Given the limitation of Blue&Go! as a development product, the recruitment period and the scope of this study, the experiment was conducted as a pilot study within classroom settings.

At the conclusion of each half of the session, participants were requested to complete a brief questionnaire designed to assess the impact of gamification on engagement and motivation (see Appendix A1). The scales used were based on engagement questionnaires from [16]. They consisted of a validated 5-point Likert scale with 18 items divided into seven sub-dimensions, ranging from "Strongly disagree" to "Strongly agree". Within the scope of this study, five dimensions were used to measure engagement: immersion, purpose, interest, achievability, and motivation. The scales used were identical for both types of gamifications and included the "student engagement" scale.

Additionally, a short survey was distributed before the experiment to request all participants to provide their demographic information, including age, gender, culture, level

of education, and expertise/experience. The correctness of their answers, motivation, and emotional state when participating in the session were also noted. Participants were asked about their experience with the applications, including comfort level, engagement, and the impact and resource effectiveness on both types of gamifications – unplugged and plugged, through a list of follow-up questions.

Data analysis was conducted using SPSS to explore descriptive statistics, identify differences between the two types of gamifications, and align with multiple variables and engagement dimensions. The study included a reliability analysis for the internal consistency of each scale, a descriptive analysis, and numerous statistical analyses. The first reliability analysis eliminated irrelevant items based on Cronbach's alpha. Five new variables were created, referring to five dimensions generated from 13 items in each validated scale. The statistical analysis compared the effect of engagement and motivation between unplugged and plugged gamification, considering differences in gender and teaching experience. Finally, the analysis of variables related to participants' perceptions of the influence of time, money, and workload and the effectiveness of each gamification, separated by the teaching experience variable.

4 Results

4.1 Analysis of Literature Review

The systematic review uncovered a predominant interest in gamification within education, though scarce research specifically delves into 'unplugged' techniques (see Table 1). A limited number of papers focus on unplugged gamification in education, with a notable dearth in studies analyzing its impact. Of the selected papers for review, six were considered highly pertinent to the topic of variables impacting unplugged gamification in education (see Table 2). These selected papers employed a myriad of methodologies, encompassing literature reviews, meta-analyses, and comparative experiments. Primary outcomes from these studies pertained to engagement, motivation, learning performance, computational thinking, cognitive load, and cost-effectiveness. However, a few limitations arose:

- Most studies concentrated on computational thinking within computer science.
- Ambiguous use of the term "unplugged gamification."
- Limited accessibility to some papers, hindering the depth of analysis.

Nevertheless, the analysis unveiled several variables influencing unplugged gamification's impact, including engagement, motivation, learning performance, and cost-effectiveness. This formed the basis for the second phase, where these variables were experimentally tested.

4.2 Comparing Engagement and Motivation Between Plugged and Unplugged Gamification

To assess the internal consistency of the scale used for measuring Kahoot! and Blue&Go!, Cronbach's alpha was employed. Given the distinct gameplay and interaction features

Table 1. Number of documents based on the indexing search terms.

Database	Key1	Key2	Key 3	Key 4	Key 5
Scholar	10300	8610	1230	123	106
Scopus	4754	838	40	7	1
IEEE Xplore	1011	116	4	1	0
Science Direct	2809	1987	606	24	13

Notes: Key1 = (Gamif* AND Education); Key2 = (Gamif* AND Education AND Effect); Key3 = (Unplug* AND Education AND Effect); Key4 = (Gamif* AND Unplug* AND Education); Key5 = (Gamif* AND Unplug* AND Education AND Effect).

Table 2. Summary of papers related to unplugged gamification and education.

Authors	Variables
Madariaga et al., 2023	motivation, engagement, enjoyment of in-game and game elements
Zhan et al., 2022	student motivation, and cognitive load; thinking skills
Cheng et al., 2023	motivation learning confidence (for completing the experimental activities)
Tsarava et al., 2019	positive experience, computational thinking
Esteve-Mon et al., 2019	computational thinking, learning gain, technical difficulty
Huang \& Looi, 2021	computational thinking, flexibility, student participation

between the two applications, some items on the scale might not be universally applicable. Preliminary reliability analysis, performed in SPSS, aimed to pinpoint items that should be excluded. The results demonstrated that the scale was aptly validated for the Kahoot! experiment, yielding a Cronbach's alpha value of 0.733. In contrast, the reliability of the scale for the Blue&Go! experiment, at 0.661, was less convincing. This indicated potential mismatches between some items and the specific experiment conditions. To address this, a more nuanced analysis was executed. Utilizing the "Scale if Item Deleted" option in the SPSS Cronbach's alpha analysis, items 5 and 8 were flagged for removal due to their poor item-total correlation values of -0.265 and analysis, items 5 and 8 were0.101, respectively. Omitting these items resulted in an improved Cronbach's alpha of 0.76 for the Blue&Go! scale. The table below presents this final Cronbach's alpha, deemed satisfactory for continued analysis.

The refined scale was then restructured into sub-dimensions. Five new variables, each signifying a unique dimension, were crafted for each scale. These were computed in SPSS by determining the mean value of chosen items. The dimensions, along with the associated items, are as follows: (a) Motivation [items 1 and 9], (b) Achievability [items 2 and 3], (c) Interest [items 4, 8, and 12 for Kahoot! | items 4 and 12 for Blue&Go!], (d) Immersion [items 6, 10, and 11], and (e) Purpose [items 5, 10, and 13 for Kahoot! | items 10 and 13 for Blue&Go!].

Subsequently, a descriptive analysis was undertaken to better understand the gathered data. The scope of this analysis encompassed two primary scales associated with Kahoot! and Blue&Go! distinguished by the five sub-dimensions, variables pertaining to resource constraints, and participants' feedback regarding engagement, motivation, and learning outcomes across sessions (see Table 3). The plugged gamification, as represented by Kahoot! slightly outperformed in overall engagement. Specifically, Kahoot! registered higher mean scores in motivation, achievability, and interest when compared to its unplugged counterpart. Participants' comfort and satisfaction with the respective platforms might account for some of these variations. For instance, comfort levels with Kahoot! were observed to be [$\mu = 4.24, \sigma = 0.63$], which surpassed the [$\mu = 3.86, \sigma = 0.91$] recorded for Blue&Go!.

Table 3. Results of descriptive analysis after scale refinement.

	Kahoot!				Blue&Go!			
	Min.	Max.	Mean	STD.	Min.	Max.	Mean	STD
Comfort	3.0	5.0	4.24	.625	2.0	5.0	3.86	.910
Motivation	1.5	5.0	3.905	.8605	2.5	5.0	3.929	.7792
Achievability	2.5	5.0	4.048	.7731	2.0	5.0	3.619	.8646
Interest	2.0	5.0	4.127	.9097	2.5	5.0	4.071	.8409
Immersion	2.3	5.0	3.841	.6962	3.0	5.0	3.936	.6112
Purpose	2.0	3.7	2.889	.4260	2.0	3.5	2.976	.5356

Interestingly, when it came to immersion, Blue&Go! symbolizing unplugged gamification, showcased a higher mean score of [$\mu = 3.94, \sigma = 0.61$] compared to Kahoot! at [$\mu = 3.84, \sigma = 0.70$]. The responses for immersion with Blue&Go! spanned a broader spectrum, ranging between 3.0 and 5.0 on the Likert scale. Yet, a shared shortcoming for both gamified methods was evident in the purpose dimension. Both showcased relatively subdued mean values: [$\mu = 2.89, \sigma = 0.43$], for Kahoot! and [$\mu = 2.98, \sigma = 0.53$] for Blue&Go!.

A mean comparison method was adopted using SPSS's Compared Means function. Kahoot! and Blue&Go!'s scale data across five dimensions were juxtaposed. For added context, two demographic variables—gender and education level—were integrated into the analysis. Notably, women displayed higher motivation [$\mu = 4.00$, $\mu = 3.88$], interest [$\mu = 4.20$, $\mu = 4.10$], and immersion [$\mu = 4.07$, $\mu = 3.78$] in Kahoot! than their male counterparts. Conversely, men exhibited stronger engagement in achievability [$\mu = 4.13, \mu = 3.80$] and purpose [$\mu = 2.96, \mu = 2.68$]. This pattern persisted for Blue&Go!. Interestingly, males demonstrated enhanced engagement in unplugged gamification (Blue&Go!) for certain dimensions compared to plugged (Kahoot!). However, women showed the reverse trend (Fig. 1).

The demographic data only provided participants' current educational or professional position. Thus, we categorized participants into two groups based on teaching experience: inexperienced (comprising BSc, MSc, and PhD candidates) and experienced

Gender_Text		Motivation_K	Achievability_K	Interest_K	Immersion_K	Purpose_K	Motivation_BG	Achievability_BG	Interest_BG	Immersion_BG	Purpose_BG
Female	Mean	4.0000	3.8000	4.2000	4.0667	2.6667	3.9000	3.3000	4.3000	4.2667	2.7000
	N	5	5	5	5	5	5	5	5	5	5
	Std. Deviation	.79057	.83666	.93095	.64118	.52705	.96177	1.09545	.83666	.54772	.57009
Male	Mean	3.8750	4.1250	4.1042	3.7708	2.9583	3.9375	3.7188	4.0000	3.8333	3.0625
	N	16	16	16	16	16	16	16	16	16	16
	Std. Deviation	.90370	.76376	.93269	.71718	.38249	.75000	.79517	.85635	.60858	.51235
Total	Mean	3.9048	4.0476	4.1270	3.8413	2.8889	3.9286	3.6190	4.0714	3.9365	2.9762
	N	21	21	21	21	21	21	21	21	21	21
	Std. Deviation	.86051	.77306	.90968	.69617	.42601	.77919	.86465	.84092	.61118	.53563

Fig. 1. Mean comparison analysis based on Gender

(lecturers and professors). The groups consisted of 13 and 8 participants respectively. The results, indicated marked differences in engagement across dimensions, influenced by the level of teaching experience. For Kahoot! participants without teaching experience showed heightened engagement in motivation [$\mu = 4.19$, $\mu = 3.44$], achievability [$\mu = 4.35$, $\mu = 3.57$], interest [$\mu = 4.54$, $\mu = 3.46$], and immersion [$\mu = 3.97$, $\mu = 3.63$]. Only in the purpose dimension did they lag slightly [$\mu = 2.87$, $\mu = 2.92$]. A parallel trend was observed for Blue&Go!, with higher means for motivation, achievability, interest, and immersion, but a marginally lower mean for purpose (Fig. 2).

TeachingExperience		Motivation_K	Achievability_K	Interest_K	Immersion_K	Purpose_K	Motivation_BG	Achievability_BG	Interest_BG	Immersion_BG	Purpose_BG
Experienced	Mean	3.4375	3.5625	3.4583	3.6250	2.9167	3.4375	3.0625	3.6250	3.6667	3.0000
	N	8	8	8	8	8	8	8	8	8	8
	Std. Deviation	.90386	.77632	.88976	.70006	.49602	.62321	.49552	.87627	.56344	.37796
No-experienced	Mean	4.1923	4.3462	4.5385	3.9744	2.8718	4.2308	3.9615	4.3462	4.1026	2.9615
	N	13	13	13	13	13	13	13	13	13	13
	Std. Deviation	.72280	.62532	.66023	.68667	.39764	.72501	.87706	.71835	.59914	.62788
Total	Mean	3.9048	4.0476	4.1270	3.8413	2.8889	3.9286	3.6190	4.0714	3.9365	2.9762
	N	21	21	21	21	21	21	21	21	21	21
	Std. Deviation	.86051	.77306	.90968	.69617	.42601	.77919	.86465	.84092	.61118	.53563

Fig. 2. Mean comparison analysis based on Teaching experience

This suggests that those with more teaching experience, being more acquainted with gamification platforms, displayed reduced engagement in certain areas. Nevertheless, they appeared to better grasp the tasks and objectives of gamified activities. Additionally, regardless of experience, participants generally found greater engagement levels in unplugged gamification (Blue&Go!) for certain dimensions. However, dimensions like achievability and interest had noticeably lower means.

A section of the survey probed participants' views on how resource constraints (RC) like time, cost, and workload could dictate the choice between unplugged (Blue&Go!) and plugged (Kahoot!) gamification types. The predominant sentiment was that these constraints, especially time and workload, did play a part in their gamification adoption decisions. Survey responses showed that the consensus was that unplugged gamification tended to be more resource-intensive. This was reflected in the mean values of [$\mu = 2.67$] for time, [$\mu = 2.43$] for money, and [$\mu = 2.81$] for workload. However, the impact of resource constraints was also subject to one's teaching experience. An in-depth analysis indicated that inexperienced teachers felt that unplugged gamification demanded more in terms of time [$\mu_{BG} = 2.69$, $\mu_K = 2.63$] and workload [$\mu_{BG} = 2.85$, $\mu_K = 2.75$], while plugged gamification was considered more costly [$\mu_{BG} = 2.23$, $\mu_K = 2.75$] in comparison to the views of experienced teachers.

5 Discussion

The core aim of this research was to delve into the comparative impacts of unplugged and plugged gamification within higher educational contexts. By undertaking both a comprehensive literature review and a practical experiment involving a diverse set of participants, the study aimed to uncover the nuances of engagement, motivation, and potential resource constraints associated with each gamification method. The goal was to discern which method, if any, offered superior educational outcomes.

The initial phase, rooted in a literature review, revealed that while gamification has consistently been shown to bolster engagement, motivation, and learning outcomes [2, 11], research specifically targeting the unplugged gamification paradigm remains sparse. However, the few studies that ventured into this realm, particularly in the context of computational thinking, indicated promising outcomes [17, 19].

The experimental phase of the research further illuminated these findings. While both plugged and unplugged modalities exhibited positive influences on engagement and motivation, the Kahoot! (plugged) experience slightly edged out the Blue&Go! (unplugged) in terms of engagement, potentially due to participants' familiarity with the system. However, a deeper dive revealed more intricate patterns. Female participants, for instance, exhibited heightened motivation, interest, and immersion with the plugged system, while males gravitated more towards the unplugged format. The teaching experience further modulated these effects, with those devoid of teaching experience showcasing heightened motivation, interest, and immersion across both platforms.

Lastly, addressing the third research question, resource constraints emerged as a pivotal factor influencing gamification adoption, especially for participants with teaching experience. While unplugged gamification was perceived to offer a more significant impact on engagement, motivation, and learning outcomes, these perceptions were intrinsically linked with considerations of time, cost, and workload.

However, while these findings shed pivotal light on the gamification landscape, the limited scale of the study and its participant demographics pose constraints on universal applicability. For a more globally representative perspective, broader, long-term studies with diverse participants are essential. Additionally, diving deeper into learning outcomes and assimilating insights from educators could offer a more comprehensive view of gamification's potential in academic settings. In summation, this research underscores the burgeoning potential of unplugged gamification, particularly in higher education settings. While both plugged and unplugged paradigms offer distinct advantages, strategic considerations like resource availability and audience familiarity play decisive roles in their adoption and efficacy. As the educational landscape evolves, the integration of these findings could be instrumental in tailoring gamification frameworks that are both impactful and resource-efficient.

6 Conclusions

This study looked at how plugged and unplugged gamification can help in higher education to keep students engaged and motivated. We did a literature review to check the progress of these topics and found that while many agree that gamification is helpful

in education, not many researchers have looked at unplugged gamification. When we tested both types of gamification in a classroom setting, participants enjoyed plugged gamification (Kahoot!) a bit more than unplugged (Blue&Go!). However, the gender and the teaching experience of teachers have a role in which gamification mode they preferred. We also noticed that time, cost, and effort are important factors when deciding which type of game to use in a classroom. While unplugged gamification have some benefits, they might take more time or effort to set up. However, our study had its limits. We only worked with a small group of people, so our findings might not apply to everyone. To really understand the best way to use games in education, more research with more people is needed. In short, our study suggests that games can be a useful tool in education. But before choosing a game, educators should consider how much time, money, and effort they can spend. More research is needed to make a final decision on which type of game is best.

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